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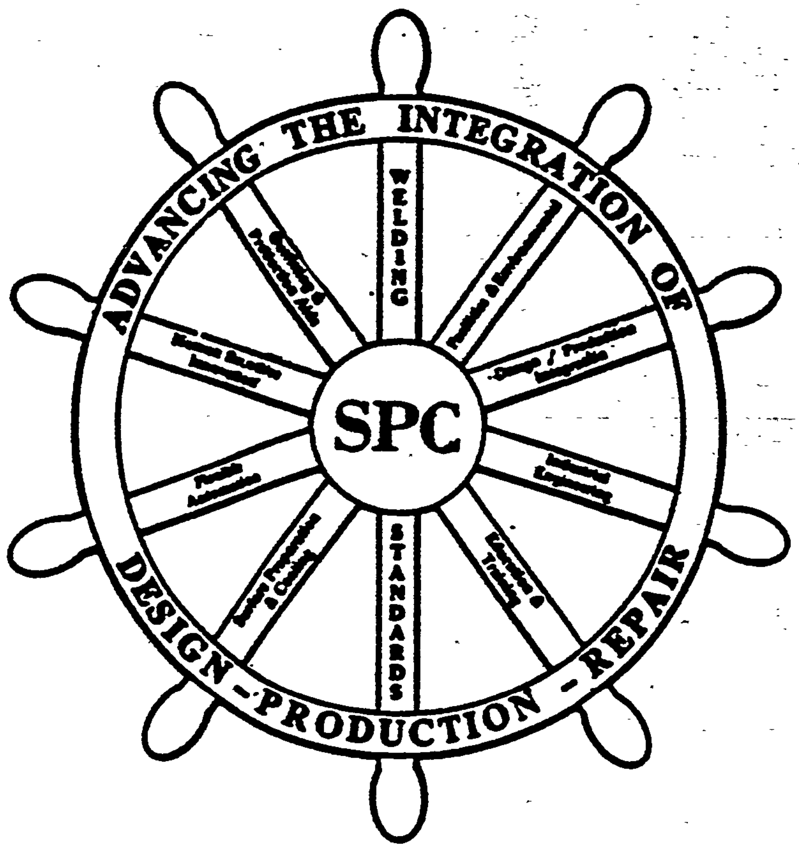

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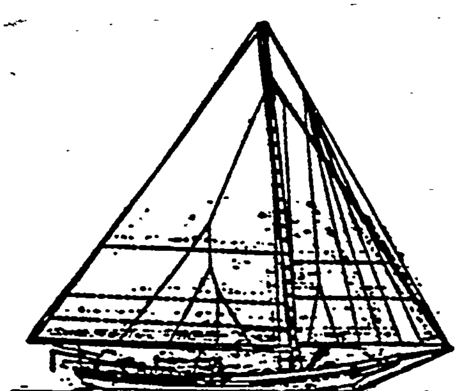

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An Integrated CAD/CAM Network for Work Packaging Development and Database Management

No. 2B

LCDR M. S. O'Hare, USN, Member, and LT M. J. Anderson, USN, Visitor, Philadelphia Naval Shipyard, Philadelphia, PA

ABSTRACT

The Zone Logic Technology CAD/CAM and networked Database Management System is an integrated system of commcrcially available, off-the-shelf computer hardware and software products. These products have been carefully selected, tailored, and integrated to spccifically satisfy and support the Philadelphia Naval Shipyard (PNSY) Zone Tccbnology Program in support of work packaging development, computer aided graphics and an on line, real-time, distributive database management system.

The process used publishing this paper serves as a small example of some of the capabilitics of the system at PNSY. The cnUrc document, including graphics, was generated on the system. Scanners, CAD and PC systems were utilized to input, develop and convert the graphics files into appropriate formats for import into a technical publications software package. LAN intcrconncction capabilites provided option developing portions of this document on different systems and at different locations with the ability IO access the appropriate files remotely.

INTRODUCTION

Philadelphia Naval Shipyard has thrust itself into the 2Istcentury in both new management and automated technologies. Senior managers arc making bold business decisions neccsary to the shipyard's survival. A pilot project has been initiated to develop and execute a transition phase to improve shipyard productivity. Major changes to management, workpackaging, production, planning, and design execution are currently ongoing Computer assistance has been developed and is being coupled with these changes, thus forming a Zone Logic Technology (ZLT) Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) and nctworked Data Base Management System (DBMS).

BACKGROUND

In understandining how Philadelphia Naval Shipyard (PNSY) developed ZLTCAD/CAM and networked DBMS one must first go back to the genesis of why this system was developed.

The largest and most comprehensive conversion overhaul and repair work done throughout the world to any vessel is that done to United States Navy Aircraft Carriers under the Service Life Extension Program (SLEP). The objective of this 37 month program is to refurbish non-nuclear aircraft carriers which have reached their designed life of 25 to 30 years, thereby obtaining another 15 to 20 years of serviceable ship life. Economically, this has proven to be much more efficent than scrapping them for new replacement aircraft carriers. To date, PNSY has successfully completed the SLEP program on three U.S. aircraft carriers (USS Saratoga(CV60), USS Forestal (CV59), and USS Independence(CV62)).

Currently, USS Kitty Hawk (CV 63) is undergoing SLEP at PNSY. However, in addition to the already definitized ship alteration and repair work package, the Navy wanted to include the Hull Expansion Project in the SLEP program-This project called for the replacement of approximately 80 percent of the aircraft carrier's existing hull with a new but wider hull. The amount of steel to be replaced and added to the hull was greater tban that used to erect the Eiffel Tower. This would bave been the largest ship alteration and repair to occur to any vessel in the history of shipbulding, conversion overhaul and repair work.

A project of this magnitude would normally have been given to the executing shipyard three to four years ahead of a scheduled start date. However, in order to be able to execute the Hull Expansion Project in conjunction with USS Kitty Hawk's SLEP,PNSYwas given only one year to plan, design, identify, order and receive material as well as to begin execution. The shipyard realized that if this project were to succeed, special action would need to be taken such as that under a war time condition. A Naval Shipyard is ideal for this and is more than capable of rising to the challenge. To successfully be able to meet the one year time table, a special project team was established and a most aggressive plan of action and milestones was developed. This plan of action called for special procurement authority of needed materials and services and a reorganization of the shipyard's normal working procedures.

In development of this plan of action, a world wide tour/investigation and analysis of major US, Canadian, British and Japanese shipyard practices was conducted. Also, numerous key members of the National Shipbuilding Research Program (NSRP) of the Society of Naval Architects and Marine Engineers (SNAME) were consulted in order to learn state of the art technologies being used in today's shipbuilding and repair environment.

Since the Hull Expansion Project was a combination of new construction and repair work, the procurement of special tools, installation devices, and additional CAD/CAM and Automated Data Processing (ADP) equipment support would be required as well as the needed steel plates, beams, etc. Also, changing the shipyard's working procedures to support the most efficient new construction and repair technique utilized today called for the obtaining of new technology and processes. This meant a technology transfer between Ishikawajima Harima Heavy Industries (IHI) of Japan, the recognized world leader in shipbuilding and repair productivity, and a U.S. Naval shipyard. It should be noted that to date IHI of Japan has provided the transfer of shipbuilding technology to ten North American shipyards as well as to South American, European and Indonesian shipyards. Realizing this and the task at hand, PNSY felt that obtaining IHI services was paramount to the successful and timely completion of the project.

Concurrently, senior leaders at the shipyard had already been internaIly reviewing ways to eliminate waste and affect a needed paradigm shift. In fact, the timing of the Hull Expansion project would serve as the perfect impetus to execute needed changes to improve shipyard productivity. The road to improve shipyard productivity through this project lead only one way. That way required changing the universally accepted model of accomplishuing ship con--version overhaul and repair work from a systems approach to an interim product approach through the use of a true Product Work Breakdown Structure (PWBS). This approach, known as Product Orientation, or family manufacturing and called Zone Logic Technology (ZLT) by the Navy, was viewed by progressive shipyard managers as the correct and most efficient/productive way to manage the Hull Expansion project. As the total scope of the Hull Expansion project was analyzed, it was found to impact some 30 percent of the already identified SLEP workpackage. Therefore, not only would the Hull Expansion project be done under the ZLT principle, but so would 30 percent of the regular SLEP workpackage. Once the shipyard started planning this work there would be no turning back to the traditional methods without spending millions of dollars in rework and adversely impacting the overall SLEP schedule.

Even with IHI's help, it was realized that a certain amount of ADP and CAD assistance would be needed in support of the ZLT effort. IHI would be instrumental in teaching managers how to develop and execute a PWBS, which included the development of work packages in the form of thousands of Unit Work Instructions (UWTs). They indicated that this would initially be a major manual undertaking and recommended that once the process is learned and understood, it should be automated wherever possible. Therefore, the need for an integrated CAD/CAM network for Work Package development of UWI's and a DBMS became apparent.

Considering the level of expertise required to put together a computerized system that would meet the project's requirements, it was decided that a Systems Integrator (SI) would be needed. The concept of utilizing an SI is standard in the private sector but is somewhat new in Naval Shipyards. This is due to several reasons, such as not truly understanding the concept or how to manage an SI . Some think that it is not cost effective, and a few even let pride stand in their way. But the use of an SI, if managed properly, is far more efficient in effectively integrating various computer hardware/software components than any naval shipyard could ever hope to be. Naval shipyards should not be expected to have the same level or broad range of computer expertise and talent that a technically qualified SI has. Considering an SI's diverse mission capabilities and resources, it should readily be apparent that they are the best qualified to integrate different computer operating systems as well as various pieces of hardware and software. The level of technical knowledge and practical experience that the SI brings to the effort more than offsets their cost. An SI has greater resources available to check all technical possibilities and the expertise in integrating different hardware and software systems that must work together. However, it is essential for the Navy to provide technical input related to the requirements of the intended system and interfaces to be installed on the systems as a whole. That is, for the system to perform well it must be not only technically sound, but it must also "fit" the environment and its users.

Under the normal environment of procurement that exists in the Navy today, the acquisition of extensive ADP support and foreign assistance is a request of no trivial proportion. Under normal methods of ADP procurement, each **system** would be procured seperately. Integration would have had to be accomplished through available standards, which do not cover the needs for interfacing various types of data. The shipyard would have also had to complete the integration after installation. The outcome of this method was extremely suspect and was not viewed as a practical solution . Also coupled with this was the fact that normal ADP procurement times range between one and three years from initiation of request to actual receipt of equipment. Therefore, the success of this project hinged on an alternate solution,

Fortunately, permission was obtained from the Under Secretary of the Navy to acquire all needed items in support of the shipyard's requirements. This included the acquisition of IHI services from Japan as well as those of an SI from the United States. Once the go ahead was given to obtain these services, immedidate action was taken. A Memorandum of Agreement between the Department of Defense (DOD) and the Ministry of International Trade and Industry (MITI) was obtained allowing IHI to assist PNSY. Martin Marietta Data Systems (MMDS) was selected as the SI. Both IHI and MMDS have had a most formidable challenge to face: IHI to teach PNSY managers how to develop and implement ZLT, and MMDS as the SI to upgrade existing equipment and integrate with new equipmenta CAD/CAM network for production, planning and design Use as well as for Work Package development via a ZLT DBMS.

Due to the high cost and risk associated with executing the Hull Expansion Project in conjunction with the USS Kitty Hawk SLEP, it was first greatly reduced in and scope and then finaly cancelled in February of '88. There was sufticient time to halt the execution of the Hull Expansion Project with only sunk cost occuring to planning and ADP support. However, as was mentioned earlier, there was no turning back on the 30 percent of the SLEP work package that was planned utilizing ZLT principles. Thus, the services of IHI and of the SI continued to be used. Though the Hull Expansion Project has been shelved, other low risk ship alteration and repair work designed to obtain similar ship mission capabilities as the Hull Expansion project will take its place. **Many** of these new items will be done under ZLT concepts and will utilize the new computer support services as required. Further, major productivity improvements are projected to be achieved not only on the replacement work but also on the 30 percent of USS Kitty Hawk's SLEP work being done by ZLT principles.

This lengthy but required explanation as to the genesis of the ZLT CAD/CAM and Networked DBMS was needed to show the critical and short fuse environment that PNSY was required to accommodate. The remainder of this paper deals with the development of the ZLT computer system.

ZLT SYSTEM DESCRIPTION

The primary functions of the ZLT system were layed out conceptually and a for final development. Ther requirements for the ZLT system are (Figure 1):

- upgrade and link existing CAD/CAM equipment needed to support SLEP.
- Convert non-electronic technical data (manually created engineering drawings, patterns, work instructions, technical reference materiaL etc) into electronic computer formats.
- Provide a Relational Data Base to manage the project.
- Provide direct file transfers between VMS, UNIX and DOS operating systems using networking technology.
- Provide the capability to create additional new or modified engineering drawings, patterns, process tapes, work instructiom, etc., using computer workstations.
- Provide interface connectivity for convenient access to other established PNSY databases, i.e, Job Order and Job Material List data resident on a Wang VS100 system and the Management Information System residing on the shipyard's Honeywell mainframe.
- Provide computer workstations and the associated software application packages necesary to create, retrieve, modify/manipulate and store data as necassary to producer
  - a. Unit Work Instructions
  - b. engineering drawings
  - c. patterns
  - d. process control tapes
  - e. Process Instructions
  - f. Naval Ships' Technical Manuals
  - g. drawings and/or documents to support other shipyards and naval offices.

Additionally, the ZLT system provides the following capabilites

- wordprocessing
- spreadsheet/graphics design
- PROMIS, an integrated project management and scheduling system

The first thing required by PNSY was to develop a set of specifications as fast as possible that would be technically accurate and realistically achievable. It was immediately decided by the ZLT Project Office that commercially available, off-the-shelf hardware

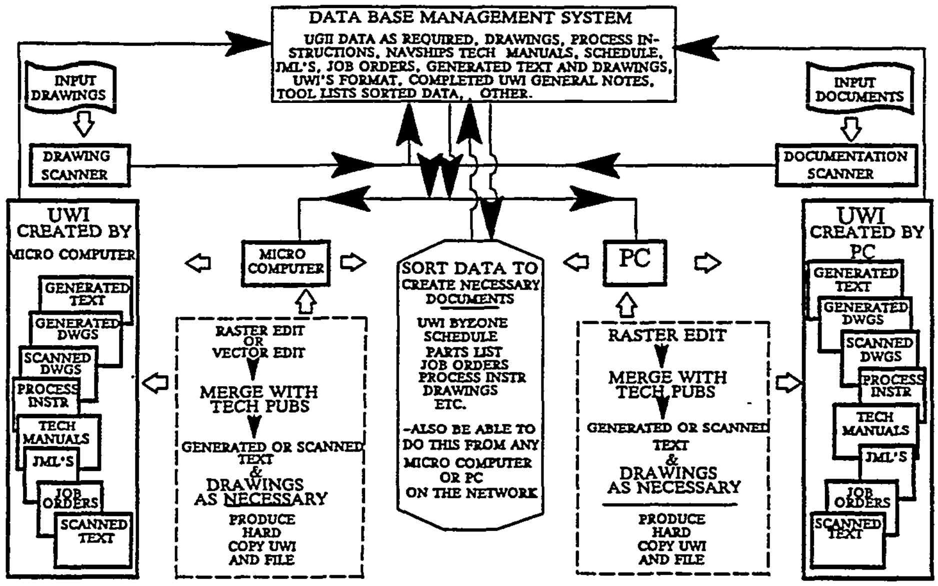


Figure - 1 ZLT System Process Requirements

and software products would be integrated and networked through the use of an SI. Direction was given to steer away from any computer futures, as so often many buyers of computer systems have failed to do. A team of seven computer knowledgeable people from within the shipyard was put together to write the needed specifications. Under the time constraints allocated, specifications were developed in only seven consecutive twelve hour days with all SI requirements being spelled out.

The functional requirements of the ZLT system are both complex and extremely varied. In recognition of these factors, the ZLT system has been developed as three major subcomponent systems

- Unigraphics Subsystem
- Computervision Subsystem
- Personal Computer Subsystem

Each subsystem consists of specialized computer hardware/software that is uniquely adapted to perform specific ZLT CAD/CAM functions. The subsystems are integrated and interfaced via the ZLT database(s) and networks to fully satisfy all ZLT CAD/CAM rquirements to develop and publish UWIs. Figure 2, PNSY Zone Logic-CAD/M System Logical Hardware Relationship Chart, graphically presents the complete ZLT hardware profile. Figure 2 also reflects a detailed breakout of subsystem hardware by geographic location (Zone) and the inter/intra connec tivity provided by the ethernet and fiber optic networks which support the UT system.

In analyzing the shipyard's CAD/M requirments in sup port of the ZLT Project, it became immediately apparent that production's existing CAD/CAM Unigraphics I (UGI) system would reach full maturity within six months of this analysis. This meant that continuous vendor support would be limited in resolving software and hardware maintenance problems. In addition, the UGIcomputer system was longer in production by the manufacturer McDonnell Douglas Corporation. Any system expansion required to support the effort would be difficult at best. Therefore, immediate action had to be taken to maintain support of production's CADKAM facilities.

It was also realized that, due to previous technical incompatabilities, design's Computer Vision (CV) 4X system was not linked to production's UGI system. Drawings done on design's CV 4X system could not be transferred to the UGI system either by hardwire or magnetic tape. As a result, all CAD drawings done in design and passed to production to support production CAD/CAM or lofting efforts had to be redone on the UG1 system. This duplication of effort needed to be eliminated in any future CAD/CAM upgrades.

Different CAD/CAM systems were surveyed at various shipyards, aerospace and manufacturing facilties throughout the country in an attempt to observe efficent, state-of-the-art CAD/CAM facilities in action. From here a game plan was formulated that would support the extensive CAD/CAM requirements needed for the ZLT Project. Results of this survey found that the most efficient appproch to improve PNSY CAD/CAM facilities would be to upgrade the already existing systems vice scrapping them for new systems. This was primarily driven by six major factors

1) Upgraded systems of both UG and CV products have maturedto the point of being extermely user friendly.

2) These upgraded systems could easily support all of PNSY's requirements.

3) Roth production and design personnel usiog UG and CV systems respectively felt more comfortable using upgraded system.

4)Minimal personnel training time would be required to shift to the upgraded UG (called UGII) and CV systems.

5)The upgraded UGII system would have a special translator written to accept all CV CADdrawing thus making that all important link up.

6)Upgrading the system would allow already exsiting shipyard software to be used.

UNIGRAPHICS (UC) SUBSYSTEM

The Unigraphia subsystem is the manufacturing support component of the ZLT system- The major functional capabilities of the UG system include the production of flat pattern layouts and

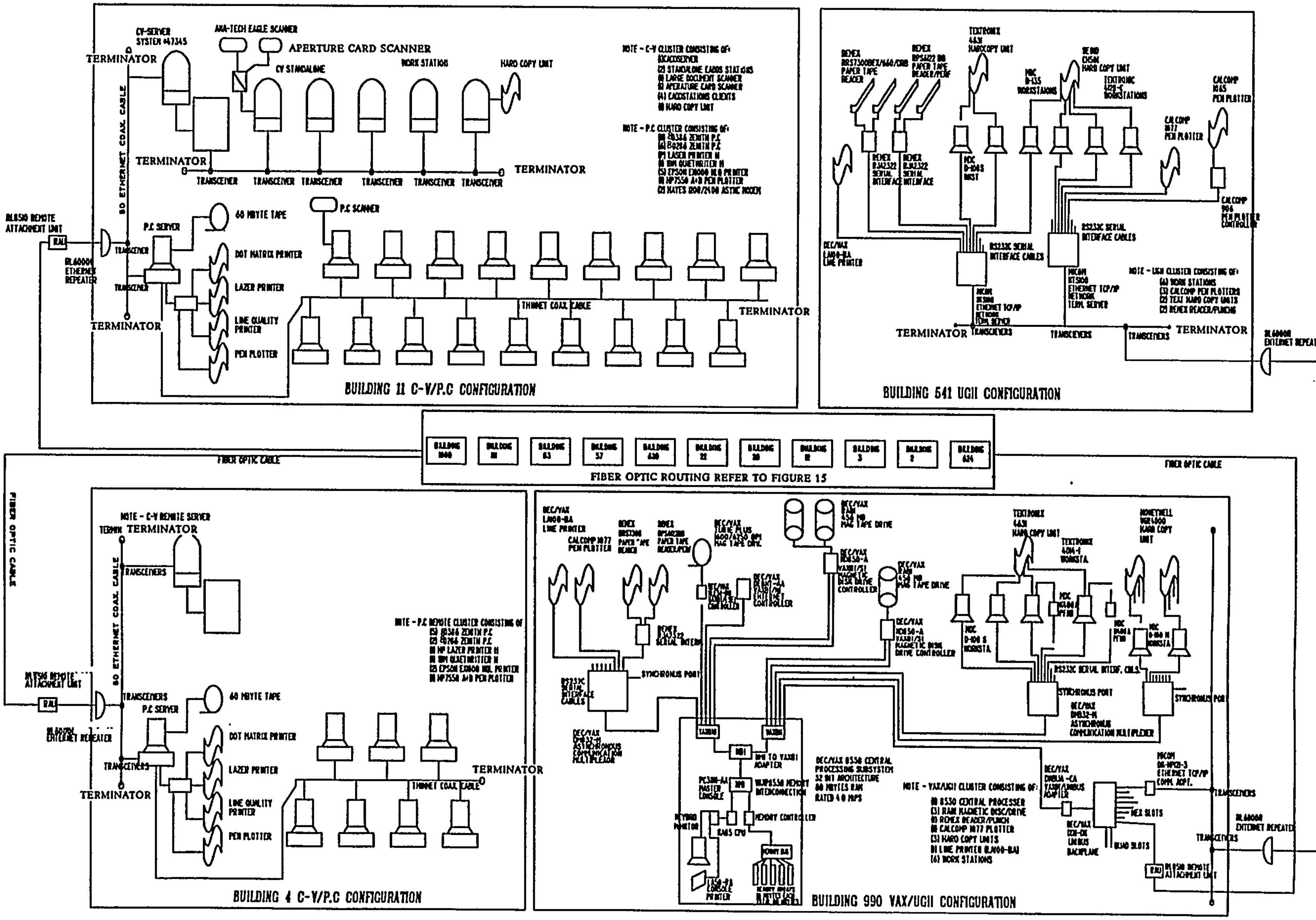


Figure - 2 PNSY Zone Logic CAD/CAM Network template designs required to support the PNSY sheet metaI shop, and Numerical control tapes to support machine shop part frabrication. In addition, the UG system aIso supports the preparation of Unit Work Instructions (UWIs) by serving as the CAD/CAM fuuction for the input of detailed dimensions, instructions and other specifics as required to complete engineering drawing files.

TheUG system also provides an extenesive darabase library of completed and in process shop drawings. The shop drawings may be retrieved for reuse or modification, as neccssary, to reflect required design additions or changes.

The UGII system, as installed at PNSY, is a proprietary software product of the McDonnell Douglas Corporation intstalled on the VAX 8530 Central Processing w&g Unit (CPU) operating under the VMS operating system. The UG installation includes the following peripheral device types:

- System consoles
- TapeDrive Unit
- Graphic Workstations
- Line printers
- PenPlotters
- Paper Tape Punch
- Disk Storage

The UGII system is an upgrade/enhancement to the UGI system previously installed and operated at PNSY. The major enhsncements include the installation of a new, high capacity DEC VAX 8530 CPU, an upgraded UGII software package, additional color terminals, and added hard copy output devices. All previously installed CAD/CAM peripheral devices associated with the initial UG installation have been retained and intergrated into the UGII system configuration .

In order to properly support Zone logic programe require ments, UG system components have been installed in two shipyard Production buildings: the Mold Loft (bldg. 541) and the Central Production CAD/CAM Center (bldg.990). Both intra and inter system communications are provided by the ZLT networks to insure the full availability of UG system capabilities at all workstations.

Production CAD/CAM Center (bldg. 990) UG lnstallation

The central Production CAD/CAM UG facility located in building 90 of the shipyard and is primariIy rcsponsible to support Sheet Metal, Shop 17, work requirements. The term central facility has been applied to the bldg. 990 installation as it is the location site for the VAX 8530 CPU. The cental facility is also functionally capable of supporting the Mold I-oft (bldg. 541) workloads as well as interfacing with and supporting UWI requirements for the CV and Personal Computer subsystems. Figure 3, Central Production CAD/CAM UG Hardware Configuration , graphically depicts the 1ogical view of all hardware components installed in the UG central facility including the CPU, peripheral equipment, design worksta tions, and the required communication devices. For additional ZLT Network detail, refer to figure 2

The following is a summary list of the UG hardware quipment installed in the Central Production CAD/CAM UG facility:

- DEC VAX 8530 CPU*
- RA 81 Magnetic Disk drive**
- TU81E Magnetic Tape Drive • *
- REMEX Paper Tape Reader
- REMEX Paper Tape Reader/Perf
- line printer (LA100-BA)
- Tektronix Hard Copy Unit (4531)
- Honeywell Hard Copy Unit (VGR40)
- MDC Workstation (D-100s)
- MDC Workstation (D-100M)
- Tektronix Workstation (4014-l)
- NOTE: *Includes master console, printer and monitor- **Includes controller.

Building 541 UG lnstallation

The remote UG facility is installed in the Mold I-oft (bldg 541). This facility primary function is to provide CAD/CAM support to the Mold Loft, shop ll, workload requirements . However the UG remote facility alsO has the capability to support the UG primary facility and other ZLT subsystemUWI requeirements

It should be noted that the remote facihty relies completely on the ZLT Network for connectivity to the VAX 8530. This requirement necessitates some additional logon procedural steps as opposed to those used for the central facility.

Figure 4,Mold Loft(bldg541)UGII configuration,provides a detailed logical view of all bardware components installed in the remote UGII facility. Figure 4 graphically portrays the interrelationship of the design workstations and the associated output product devices as well as the communication system interconnect to the central facility and/or other ZLT subsystems. For a more

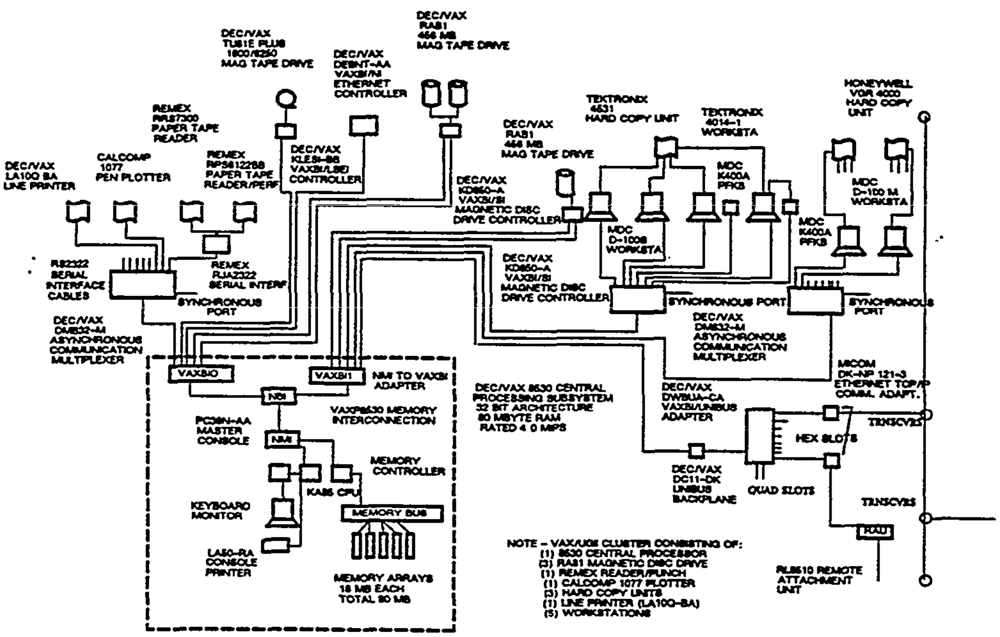


Figure - 3 Central Production CAD/CAM (bldg 990) UG System

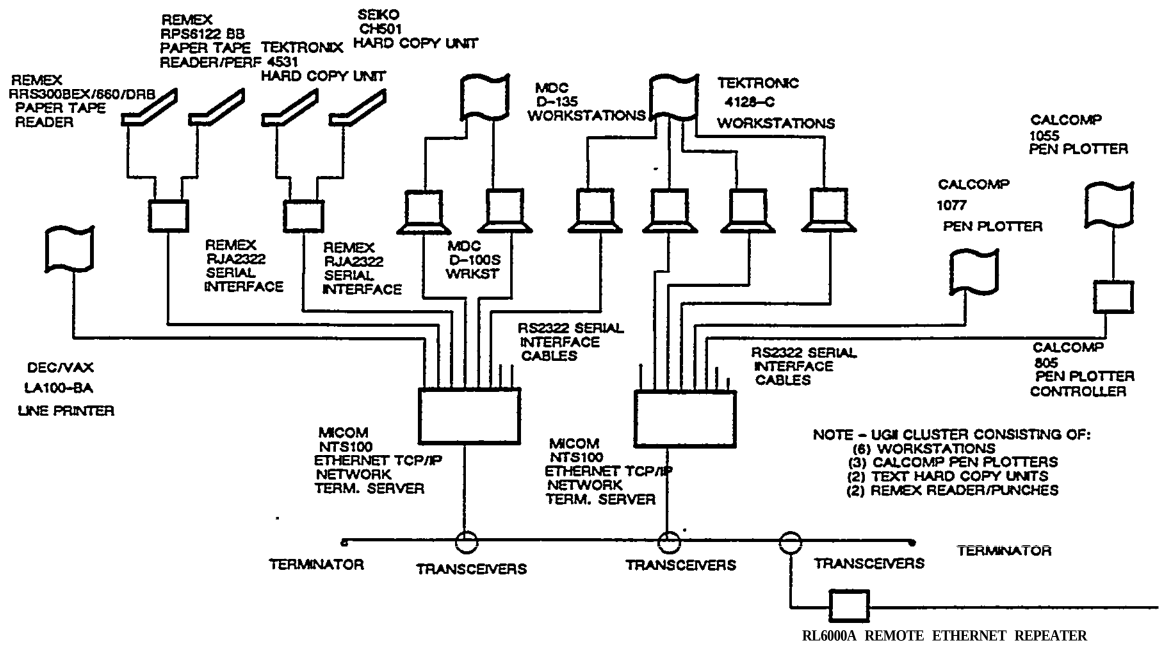


Figure - 4 Mold Loft (bldg 541) UGII System

detailed view of the relationship of the remote facility to the entire ZLT system, refer to figure 2

The following is a summary list of the hardware components installed in the Mold Loft:

- MDC Workstations (D-1005)
- MDC Workstations (D-135)
- Tektronix Workstations (4128-C)
- Line Printer (LAl00-BA)
- REMEX Paper Tape Reader
- REMEX Paper Tape Reader/Perf
- Tektronix Hard Copy Unit (4631)
- SEIKO Hard Copy Unit (CH501)
- Calcomp Plotter (1077)
- Calcomp Plotter (1065)

COMPUTERVISION (CV) SUBSYSTEM

The primary role of the CV subsystem is to provide the capability to input and/or to create technical documents or images for storage in a UWI publishing database. Existing engineering drawings, technical reference manuals, and process instructions maybe scanned and converted into computer based files, additional new engineering data and images may be generated using the CV workstation facilities, and the CV system may access other PNSY computer system databases via network facilities while performing this major function. Using the CV Caddstation, the data necessary for specific UWI development is assembled/generated, integrated, formatted and published. The UWIs are then routed and distributed to the appropriate Zone manufacturing or repair/maintenance shop for scheduling and work accomplishment.

The CV Subsystem, as with the UGII Subsystem, is installed as clusters in two seperate zones. The central CV duster, which supports the Zone Technology Outfit Planning Team and the Zone. Technology Production Group, is located in the ZLT Outfit Planning Section (bldg.11), while the remote cluster is located in the Engineering Management Center's Central CAD/CAM room (bldg. 4). Each cluster is then interfaced and connected through the ZLT communications network (both ethernet and fiber optics) with all ZLT CAD/CAM subsystems in order to facilitate system wide data transfer/access for UWI development.

Scanner Utilization

In support of the ZLT Project, the ability to include hardcopy drawing information in the UWI packages is essential. The addition of Z-D or 3-D graphics in a UWI provides a total software package in support of a unit of production work. Initially this meant performing the tedious task of cutting and pasting thousands of drawings into UWIs. This task without a doubt needed to be automated to provide a more efficient process of UWI development. During the shipyard's investigation of various industrial and manufacturing facilities, the utilization of scanners in several applications was found. This information, coupled with the shipyards and the SI's technical knowledge of scanners, led to the only accurate conclusion to be drawn: today's scanner technology could meet the requirements and priorities to support the ZLT Project, the basic requirements being:

1)Scan drawings upto 40 inches in width and unlimited length (thus allowing for the scanning of A, B, C, D, E, F and H size documents).

2) Scan drawings off of Mylar, Velluma or paper.

3) Scan drawings from aperture cards.

4) Provide IGES, direct CAD Database, and networking-direct system to system interfaces.

5) Provide both raster and vectorization as well as raster and vector editing of geometry, line widths, fonts, etc

6) Allow for raster compression and decompression.

7) Provide optical character recognition of both standard fonts and various handwritten lettering.

8)Maintain the time required to rasterize from an E size sheet at or below five (5) minutes.

9) Allow rectification of dimensions vs geometry.

10) Support layering of geometry, text and borders as well as provide foreground and background.

11) Scan document size pages such as those found in Naval Ships Technical Manuals or Process Instructions. This means allowing for recognition of various text fonts as well as graphics.

l2) Be compatible with the SUN processor, allowing the shipyard's existing CV system to act as the host. This would minimize the cost of hooking scanners onto the system.

Once the basic requirements were met, there were three (3) major priorities for the drawing scanners:

1) Scan and provide raster images to be used on UWIs..

2) Scan and vectorize 'on the fly,' providing as many CAD entities as possible without user intervention (thus reducing the time required to produce full CAD drawings from existing hardcopy paper drawings). These vectorized drawings are to support the shipyard's design CAD CV effort

3) Scan and vectorize production drawings in support of the shipyard's UGII system.

The shipyard's decision to purchase ANA-tech's Eagle scanner and Versatce's aperture card scanner was based on their capability to meet all requirements and priorities as well as their ability interface with the shipyard's IBMPC/AT, SUN-3 and DEC workstations, ANA-tech's advanced editing capabilities were also a major factor during the technical evaluation of scanning devices. ANA-tech supports two (2) software utilities that are controlled interactively with mouse and menu RED is a raster editor that allows a raster file to be viewed, edited and archived time and time again; GE is a graphics editor that provides the ability to further enhance, clean up, and compress the data. The GE editor functions include addition, deletion and generation of graphic representations such as lines, circles and polygons as well as a text utility that allows the user to revise or define new and existing fonts. The final and most important factor was the ability to convert and transfer raster and vector files to a number of software packages such as tech pubs, CAD, and wordprocessors.

The typical data flow is shown in Figure 5, with an explanation of the various main steps provided below:

1)Scan an existing drawing

2) View and edit raster data

3) Raster data plotting output.

4) Transfer raster data to and from disk storage.

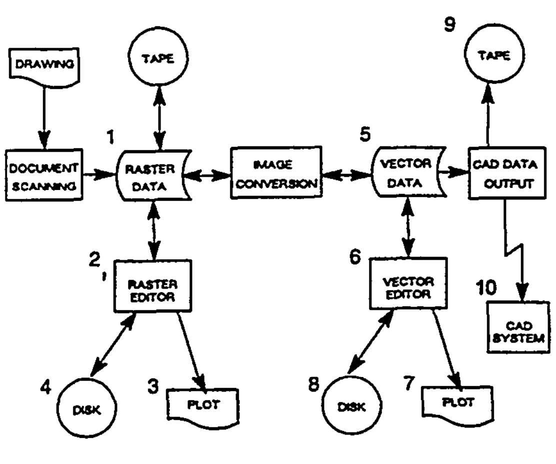


Figure - 5 Scanned Data Plow

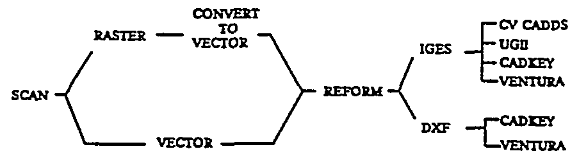


Figure - 6 Vectorizing How Path

5) Convert raster data to vector data.

6) View and edit vector data

7) vector data plotting 0utput

8) Transfer vector data to and from disk storage.

9) CAD formatted output to magnetic tape.

10) CAD formatted output networked to CAD system

note:4&8 can be same disk unit.
3&7 can be same plotter unit.

As illustrated in Figure 5, the scanner software supports the creation of raster files as well as CAD databases. The actual vectorizing data flow path of a scanned drawing is shown in Fig.6.

The path shown in Figure 6 represents a drawing that is scanned and converted to a vector file. Initially, short vectors are formed "on the fly" through ANA-tech's software. These vectors are not yet suitable to transfer to a CAD database. Therefore after the. initial vector conversion the vectors are given CAD intelligence through a program called "Reform." The "Reform" process is somewhat lengthy in CPU time (i.e., one (1) to five (5) hours or more depending on drawing density). However, this process is basically transparent to the user because he need only give the command to execute the "Reform" program.

Upon completion of the "Reform" process all vectors have been given CAD intelligence and are ready for conversion to an IGES or DXf file. From here, the IGES file can be transported to CV CADDS, the UGII CAD system, or to Cadkey directly, while the DXf file can be transported to Cadkey or Ventura directly.

Once a file is in the appropriate CAD program, it will still require some manual clean up. The amount of clean up varies with each drawing. For example, the time required to scan, vectorize and clean up a medium density drawing scanned at 200 to 300 dpi would be approximately eight (8) hours Although this may seem lengthy, the alternative method of manual input and digitizing could take about five(5) times as long.

PNSY has begun working out the best procedures to reduce the overall time of this process. In some cases, it has been found to be more time enhancing to scan and raster edit before vectorizing. This saves in clean up time of the final CAD file because extraneous information not required to be vectorized can be deleted beforehand. However, this is dependent upon information needed for each scanned drawing. The shipyard's overall intentions are to define the best procedures to be utilized when scanning and to make as many steps as possible transparent to the user to reduce user intervention time.

The actual scanning process currently used at PNSY is shown in Figure 7.

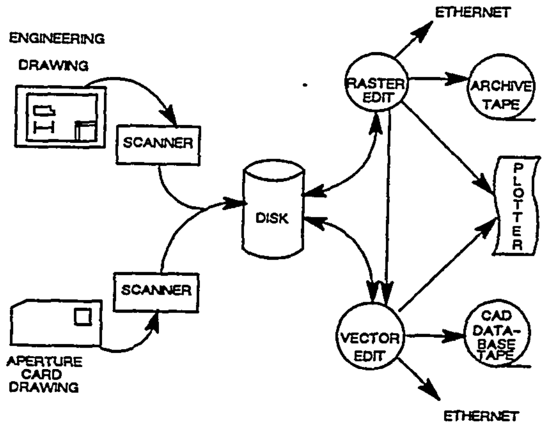


Figure-7 Scanning Process

The need for a scanner to handle the voluminous amount of documents consisting of both text and graphics required a stand alone scanner capable of supporting this specific requirement.

The Palantir Compound Document Processor (CDP) was found to be the leader in setting the standard for automated document capture in achieving nearly perfect recognition. The use of proprietary character recognition algorithms allowed for true omni-font character recognition and image processing in a single pass-through of the scanner. No user intervention is required to define characters or otherwise train the scanner to recognize special characters, nor is there any requirement to download special fonts. Furthermore, automation is enhanced by using predefined templates which allow the Palantir document scanner to be instructed to read specific regions from every type of document that is to be processed, with the identified zones enabling matching of pages and templates so that a stack of different pages can be processed automatically without presorting. Thus the Palantir document scanner was chosen. It also provided the most flexibility in scanning documents of varying quality through features such as adjusting the thresholding for background intensity either manually or automatically, as well as registering the documents for skewing. Furthermore, a spelling dictionary is included. This scanner has also been linked into the networked system.

CV Central Cluster

The central cluster, installed in the Outfit Planning Section (bldg.11). is the primary facility for the production of the UWI's. In addition to this functional responsibility, the central cluster also provides an extensive capability for the generation of detailed engineering designs and drawings necessary to support UWI development and publication- The scanners (ANA-tech Eagle drawing scanner and Versatech Acris aperture card scanner) allow scanning of numerous medias ranging from paper to aperture cards. There are two distinct forms of data created via scanning: raster and vector. This raster and vector data can be edited to clean up the drawings after the scan is complete. The system supports both a raster editor (RED) and a graphics editor (GE).

Figure 8, ZLT Outfit Planning Section (bldg. 11) CV Configuration graphically presents a logical view of the major hardware components installed in the central cluster. These components include the CV Server, standalone and client workstations, attached scanning and output peripheral equipment, and basic telecommunications devices/connectors. The CADD station configuration is shown in Figure 9. For additional details of the overall ZLT System and network relationships, refer to figure 2, PNSY Zone Logic CAD/CAM System Logical Hardware Relationship.

The following is a summary list of the CV subsystem hardware installed in building 11:

- CV Server System
- CV Standalone Workstation
- CV Client Workstations
- ANA-tech Eagle Scanner
- Versatec aperture Card Scanner
- HardCopy Unit
- Imagen Laser Printer

CV Remote Cluster

The CV remote cluster, installed in the Engineering Management Center (bldg. 4). currently consists of a single CV server. This installation is primarily established to provide engineering design functional support for engineering and administrative support personnel located in Bldg4. The remote CV server is interfaced to the central cluster and other ZLT subsystems via the ZLT network, and when workload requirements dictate, is fully capable of supporting Bldg. 11 UWI production. Figure 10, Engineering Management Center remote CV/PC Configuration, depicts the logical view of the Remote CV hardware and PC hardware (colocated at the Bldg. 4 installation). It should be noted that the remote CV cluster, as in-

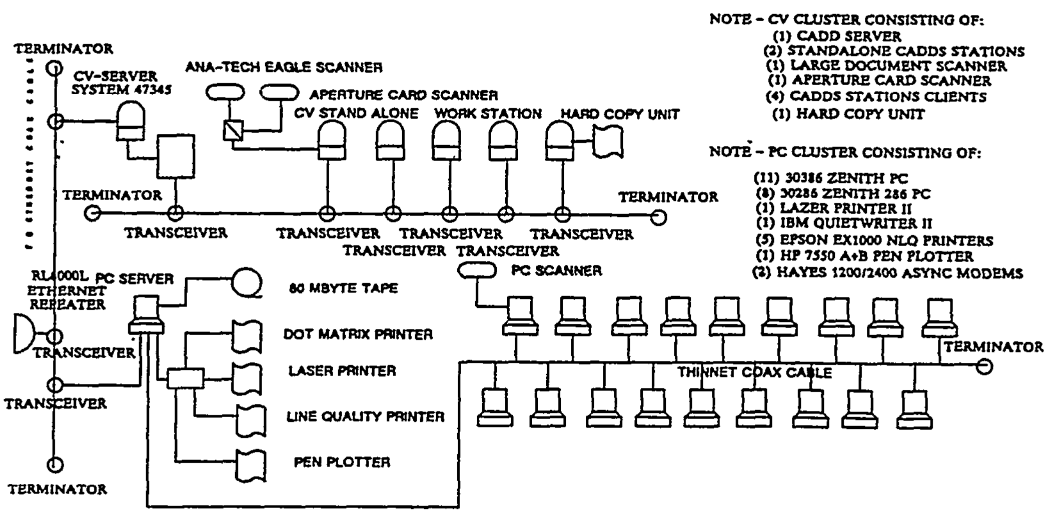


Figure - 8 ZLT Outfit Planning section (bldg) CV System

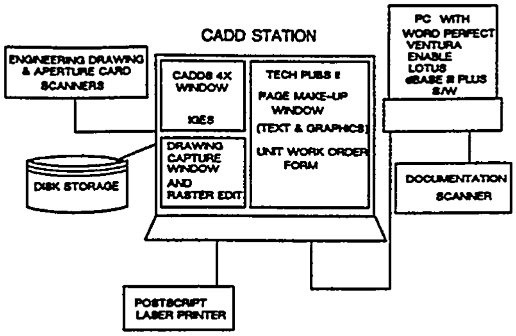


Figure - 9 Cadd Station Configuration

stalled, is also linked to the system's existing CV 4X workstations running onfour (4)CGP200X processors. This CV duster has been designed to be easily upgraded and enhanced with additional CV Caddstations should future work load requirements dictate the need for expansion. The CV remote system utilizes:

• cv server system
1CV stand-alone station

PERSONAL COMPUTER SUBSYSTEM

The microcomputer subsystem is intended to be the hub of the ZLT system. This hub is built around a core of Zenith 80386 personal desktop computers and is supplemented by Zenith 80286 PC's. These PC's are being utilized for several principal tasks: preparation and electronic distribution of UWI's, maintaining the Status and Control Database System, and an electronic mail system capable of passing text and graphics files. The UIWI's are documents which consist of technical instructions and images Technical reference manuals, process instructions, and CAD drawings which describe how work should be performed, form the input into these UWI's- In order to prepare the UWI's from these different sources, scanning and network facilities permit these documents and drawings to be scanned and converted into a computer-based file which can be readily shared by each PC workstation for merging and editing Integration into the CV and UG subsystems via PNSY network facilities permits easy to databases on these other PNSY comPuter systems

Technical desktop publishings software is used to integrate the instructions with the diagrams and pictures to generate the finished product Professional instructions that are clearly illustrated are output on laser printers with typeset-appearing quality for distribution to the various engineering and repair shops in order to refurbish/repair ships at PNSY.

The Status and Control Database System provides the mechanism to maintain control over work that is to be accomplished by the use of Shop Work Instructions (SWIs) and UWIs. Scheduling and monitoring the status of SWI's and UWI's is accomplished through the use of a sophisticated LAN database in conjunction with a network of PCs. Integration of the PC network into the larger PNSY computer network allows access to and input from other computer database systems on the base via this network. In order to sup port these principal functions for the ZLT system, PC clusters have either been or are now being installed in several locations: the Engineering Management center (bldg.4), ZLT Oufit Planning Section (bldg. 11), Management Information System Center (bldg. 83), USS kitty Hawk (CV 63) shore site (bldg. 620), and at the production worksite. Each of these is tied in with each other and with the CV and the UG computer systems via the PNSY fiber optic network providing a totally integrated, computerized database and technical publishing system in support of ZLT requirements.

Central PC Cluster - ZLT Outfit Planning Section

The PC cluster in the ZLT Outfit Planning Section (bldg. 11) produces the bulk of the UWI's and SWI's scanning for inputting existing documents, as wellas editing and creating instructions and drawings using word processing and Cadkey Computer Aided Design software and merging these instructions with the pictures for final typeset quality printing using Ventura's desktop technical publishing software. The PC network configuration in building 11 consists of:

Item Description

l Zenith 5MB386 Network Server 4OMB 2Ser/Par Monochrome Card (also includes 150MB Core International internal H/Disk). Attached is an external Genoa 6OMB tape backup device and automatic parallel/serial data switchbox for network printers and plotters using a Zenith monochrome monitor

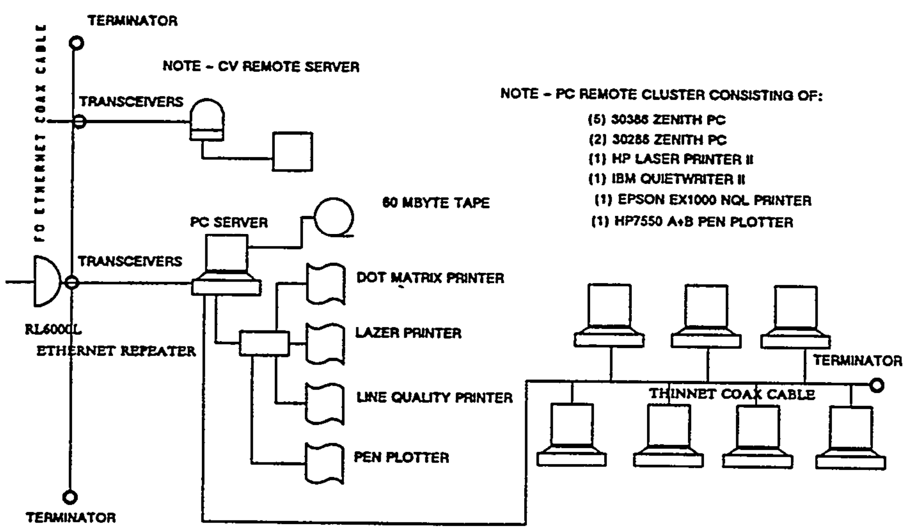


Figure - 10 Engineering Management Center CV/PC System

- Zenith 386 2MB RAM 2Ser/Par 40MBH/Disk80387 Workstations using Zenith EGA monitors

- Zenith 286 2MB RAM2Ser/Par 20MBH/Disk 80287 Workstations using a Zenith EGA monitor

- Mouse Systems Mouse

- Peripheral Equipment

  - HP Laserprinter II with 2.5 MB

  - Letter Quality printers

  - Highspeed 132cps dot matrixprinters

  - 8-pen Plotter capable of producing A and B size drawings

  - Palantir CDP optical character recognition/image scanner

Remote PC Cluster - Engineering Management Center

The PC cluster inthe Engineering Management Center(bldg. 4) primarily uses the network for monitoring and controlling the production schedules and reviewing UWI's using the Status and Control database. The configuration of the PC's networked together in support of ZLT in Building 4 is as follows:

Item Description

- Zenith 5MB 386 Network Server 40 MB 2Ser/par 80387 Monochrome Card (also includes l50 MB Core International intemal H&k). Attached is an external Genoa 60MB tape backnp device and automatic parallel/serial data switchbox for network printers and plotters using a Zenith monochrome monitor

- Zenith 386 2MB RAM 2ser/Par 40MBH/Disk 80387 Workstations using Zenith EGA monitors

- Zenith 286 2MB RAM 2Ser/Par 20MB H/Disk 80287 Workstations using Zenith EGA monitors

- **Mouse Systems Mouse**

- Peripheral Equipment

  - HP Laserprinter II with 2.5MB

  - Letter Quality printers

  - High speed 132 cps dot matrix printers

  - g-pen Plotter capable of producing A and B size drawings

  - Hayes l200/2400 Async modem

Remote PC Cluster -Management Information Center (bldg. 83)

The PCcluster in the Management Information System (MIS) Center will link twenty (20) PCS on a Local Area Network (LAN) which primarily supports MIS functionally related responsibilities. More importantly in relation to the rest of the network is the ability of shipyard managers to be linked directly to MIS to acquire necessary real-time information. Currently, the Director of the Information Systems Resource Office is developing aplan to be able to down load MIS information to the LAN for distribution to key sites in the shipyard via the server linked to the fiber optic backbone. The move in this direction is most significant because, in the shipyard's current environment, hard copies of needed MIS information must be printed and then distributed. Due to time delays in printing and distribution, often real-time data is not available as required This move is seen as a real enhancement to the shipyard and to the Zone Technology Project, which requires real-time Cost Schedule Control (CS^2) data compiled in MIS to ensure that the proper controls of production work can be realized.

Remote PC Cluster - U S S Kittv Hawk (bldgs. 620 & 5)

The PC cluster is to be located in building 620 and will link vi a a LAN some thirty (30) PCs to be used by USS KittyHawk(CV63) personnel in monitoring, progressing, scheduling and working ship's force work throughout the SLEP availability. They will also be linked to the shipyard's Fiber Optic (F.0.) backbone through their server. This must be seen as not only a first for the shipyard, but as a major breakthrough in communications with its biggest customer.

This direct link up between the shipyard and aircraft carrier personnel will be a time as well as cost saver in passing real-time data, UWI, ZLT schedules, and routine information via electronic mail to any ship's force personnel linked to the system. This is because every ship's force department involved with the SLEP availability will be linked to the LAN and therefore have access to anyone in the shipyard on the F.O. backbone. Currently, USS Kitty Hawk Data Processing and Data Systems specialists are receiving training from the SI and the ZLT Project Office on how to operate and maintain this new system.

Building 5 in the shipyard is also being used to support USS Kitty Hawk's Shipboard Non-Tactical ADP Program (SNAP I) system There are a couple of PCs in that building that will be linked directly to the F.O. backbone to allow similar communications as in building 620. Should USS Kitty Hawk expand its PC use in building 5, a server and LAN will be installed to link all of the PCs together.

SOFTWARE PACKAGES AND TRAINING

The integration of the various operating and hardware systems involved with the ZLT computer system is an immense task. Perhaps the most critical element requiring integration, however, is the user and the various software packages installed to tie the user into the system in an efficient and productive manner. It was realized from the outset that the introduction of ZLT to PNSY required a substantial shift in the traditional philosophies of shipyard work structuring and accomplishment. Along with the restructuring would come the introduction of many new 'tools" whose successful utilization would hinge upon user acceptance.

The ZLT Computer System is one of the critical "tools" required to ensure success. A major hurdle recognized immediately was that many of the workers who would be required to utilize the system for design, planning, scheduling, workpackage development etc., had at best minimal experience, if indeed any, with computers. Therefore, it was neccessary that the end users be introduced to the computer system and commence using it, even if only in a limited manner, as soon as possible. Accordingly, a large scale training plan was set in action to introduce the users to computer usage and to the various software packages installed in the system

Initially, the SI was approached with the task of procuring the extensive timing that would be required to cover the vast array of software packages involved. The SI recommended various outside sources and suggested that the shipyard contract directly with the training sources rather than utilize the SI. The cost savings realized by bypassing "middleman," on his own suggestion, were substantial.

A local community college was contracted to provide on-site training a dedicated classroom having been set up using ZLT computer equipment. Over the course of the subsequent eight months, more than three hundred training slots were tilled covering more than six different software packages, including Enable, an integrated package involving word processing, data base management and spreadsheets (though not the package designed for ultimate ZLT use, it proved to be highly successful in providing a basic introduction to the types of software that would be used), Ventura, a PC-based desktop publishing package, Cadds 3-D design, and the industrial version of Cadkey, a PC-based 3-D design package. Training for dBase III Plus, the intended data base management package, was obtained from yet another training source in the immediate area. Additionally, over thirty production personnel were given UGII training to support the major CAD/CAM upgrades.

Training support for the scanner and CV workstation software was obtained from the respective vendors. Workers were trained in the use of the ANA-tech scanning software resident on the CV workstations. This training covered use of the scanners and the paster and Vector Editor packages as well as the various conversion routines necessary for passing files to other systems Selected individuals were also trained in the use of Interleaf, the CV based technical publication package.

Future training plans call for training in the use of the wordprocessing package WordPerfect, advanced training in dBase III Plus, additional training in Ventura and overall systems training on proper utilization of the LAN.

As a result of this extensive training effort the ZLT computer "tool" has been introduced to the critical end users in a manner that has changed the prevalent attitude from "I can't use this" to let me see how I can use it more effectively."

FILE CONVERSION/INTER-LAN FILE TRANSFER

The ZLT system consists of eight (8) separate LANs found in six (6) different buildings and locations and will support over one hundred (100)PCs, twenty (20) CV Cadds 4X workstations running on four (4) CGP 200X processors, seven (7) CV stand-alone CAD workstations, twelve (12) UGII CAD/CAM stations, a VAX 8530 CPU, and various pieces of peripheral hardware by end-summer of 1988. Each LAN is supported by a server and has a number of software packages running along with output devices

The ZLT system, illustrated in Figure 11, supports three operating systems (Unix,VMS,andMS-DOS) and several software packages (Cadds 4X, Engineering Documentation, Document and Drawing Scanning, Paster editing, Vector editing, paster to Vector conversion, Interleaf, Unigraphics, Ventura, the industrial version of Cadkey, Enable, WordPerfect, dBase III Plus, Palantir software, Novell TCP/lP, Lotus, DBGraphics, MathCAD, Chartmaster and an Engineering QA statistical package). These all serve several software functionalities such as Design, Manufacturing/Engineering and Outfit Planning. They are all linked on a fiber optic(F.0.) ethernet backbone. The data flow between these systems is illustrated in Figurel2

Future plans call for the shipyard's MIS terminals and numerous independently operated PCs (i.e., SNAP/Wang) to be linked to the F.O .ethernet backbone. However, Wang does not currently support ethernet This is an unfortunate situation not only for PNSY but also for the Navy as a whole The integration of Wang terminals to an ethernet backbone could save thousands of dollars annually in the reduction of modems and twisted copper pair phone lines. The other potential benefits are too obvious to mention and it is hoped that the Navy can persuade Wang Systems to capitulate on this matter before long.

Input to the system is handled a number of ways, ranging from the scanning of data to the manual input of data. The system has a number of conversion utilities that support file transfer to and from all LANs on the system. This section illustrates paths available for the transfer of data between LANs and output devices Figure 13, Data File Conversion/Transfer Paths, shows a number of paths available utilizing conversion routines on each system. The paths are numbered and a detailed explanation is provided below

1)ANA-tech Scanner Raster Files(Ird). Raster files area one to one picture. ANA-tech supports a raster editor allowing some clean up capabilities. ANA-tech also supports vectorization of these raster files and has a graphic editor for cleanup.

2) Palantir Scanner is a document scanner that allows the scanning of text/graphics. The file is broken into two seperate files editing is required. The graphics editing and text editing are handled by seperate pieces of software. The Palantir also supports conversion utilities allowing file transfer to other software packages.

3) This box shows a typical document (Text/Graphics) that has been scanned by the Palantir, converted and transferred into Ventura (technical publication package) and printed on the

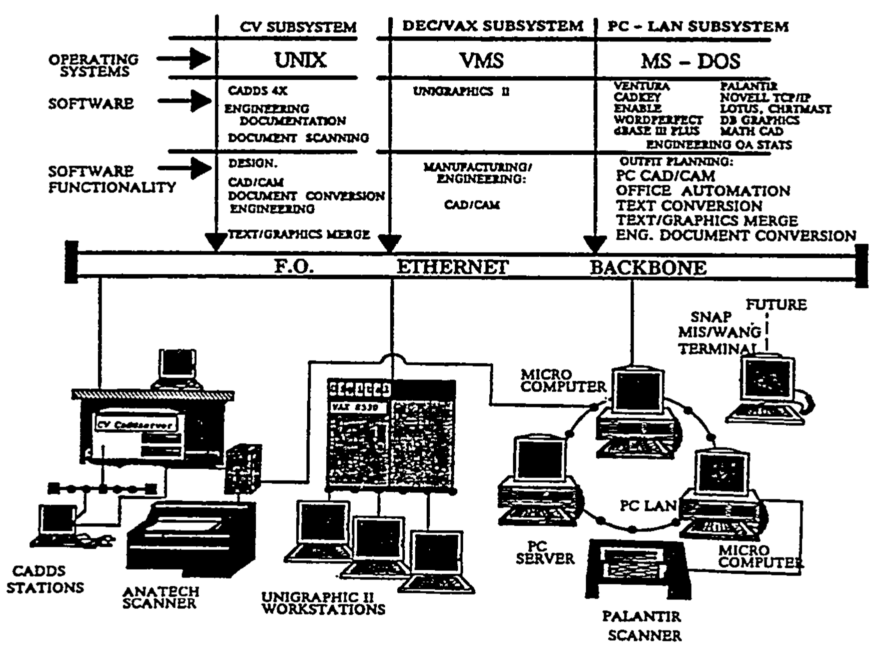


Figure - 11 ZLT Operating Systems

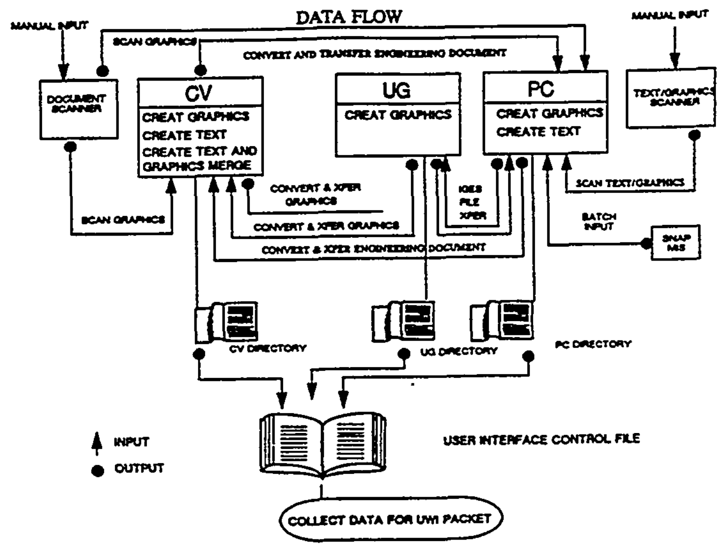


Figure - 12 lntersystem Data flow

HPLaserprinter. No editing can be accomplished in ventura when the We is transferred in as a text/graphics We.

4) This box shows a document (text only) that has been scanned by the Palantir, converted to ASCII and passed to Ventura and printed on the HP Laser printer. Text-only files and graphics -only files can be edited before printing.

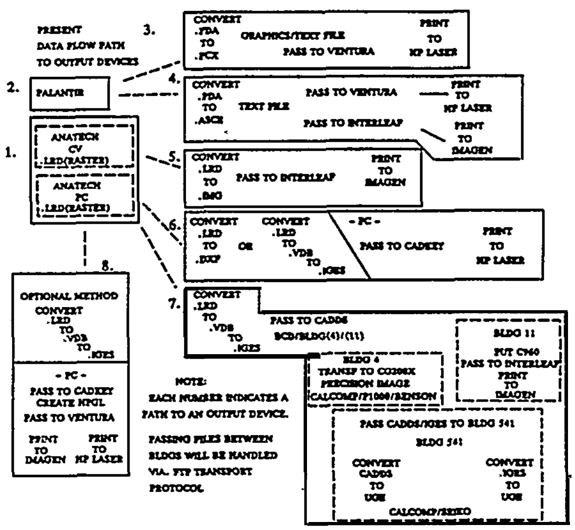


Figure - l3 Data Pile Conversion/Transfer Paths

5) This box shows an ANA-tech raster We that has been converted to img (Interleaf extension) and passed to lnterleaf (publishing package) for printing on the Imagen printer, a highspeed laserprinter.

6) This box shows an ANA-tech raster We that has been converted to either a dxf (Cadkey extension) or iges (accepted by Cadkey) We and transferred to Cadkey for printing on the HP Laser printer.

7) This box shows an ANA-tech raster file being converted to an iges We and transferred to any system that supports the iges file transfer routines. CV, Cadkey, UGII and a large number of CAD/CAM systems support the Iges format. After completion of transfer and restoration of the iges file to a part We, plotting can be done as part of the normal routine. The ZLT system has access to a number of plotters such as Calcomp, Benson, P10, and Precision Image (a high speed color electrostatic printer).

8) This box shows the method required to transfer an ANA-tech raster We to Ventura to allow printing on the HP Laser printer. Since all of the software packages reside in different buildings and LANs, it is important to know that FTP (Pile Transport Protocol) is used to get the files from one system to the other. Each system has on-line tutorials on the use and applications of FTP.

Note:Infigure l3, boxes are used to show full paths from one input to an output device. An operator is capable of starting at any point, generating a document and sending the data in a similar manner to the output devices referenced in figure13.

Figure 14, Proposed Data file Conversion Transfer Paths, shows a breakdown of proposed paths currently being developed and refined for transfer of data from input to output devices. Item numbers l thru 5 show the possibilities of plotting raster data directly following the scanning process.

1) ANA-tech raster scanner (Jrd) to a Versatec plotter. Three items are required to support this application:

- A Versatec Plotter
- DA-Ver (Versatec output control inter face)
- Lrd2Ver (conversion software)

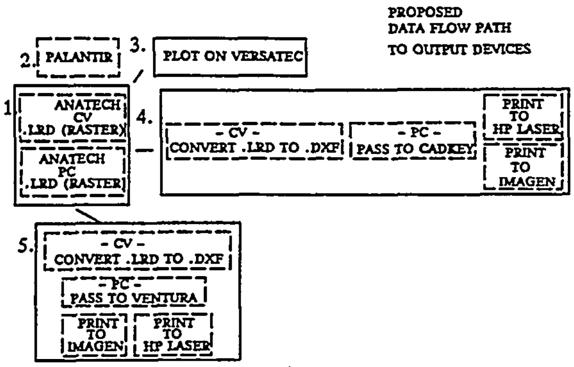


Figure - 14 Proposed Data Conversion/Transfcr

These items allow a scanned document(Jrdraster)to be output directly to a Versatec plotter that is connected to the ANA-tech scanner. Drawing replacement and reproduction is handled quickly utilizing this method.

FIBER OPTICS NETWORK

A Fiber Optic (F.O.) Cable system has been installed at PNSY to link together building facilities for new and existing CAD/CAM and ADP equipment in support of ZLT. Sixteen (16) major shipyard sites have been linked on a central active star Local Area Network by approximately five (5) miles of F.O. cable.

One of the primary functions of this system will be to support ZLTCAD/CAM requirements. The system uses the ethernet IEEE 802.3 networking protocol and provides ten million bits/second bandwidth or greater (Le. maximum data transfer rate) capacity. The cable plant has been designed to **satisfy ZLT requirements** and to provide a backbone for shipyard data communication. Initially, electronics are being installed to support all ZLT locations. However, this state-of-the-art fiber optics system will support over 1,500 transceiver cable ports. Also, with the use of terminal servers and multi-post transceivers, over 200.000 ports/connections maybe supported.

The overall potential to iii every shipyard computer system within the buildings indicated below, now and in the outyears, is possible. Immediate access to the fiber optic backbone wig be a function of each system's ethernet capability or supporting protocol Every shipyard computer system will be evaluated and appropriate software and electronic hardware will be specified for future procurement and hook up to the system. In the long run, this will yield cost savings in the hundreds of thousands of dollars in the reduction of twisted copper pairs currently being used to transmit data.

Numerous Wide Area Networks (WAN) linking the building facilities will provide support to local file/data exchange and the resource sharing requirements that will aid cost effective management throughout the network. Transmission is provided via a F.O. cable and an Ethernet coaxial 50 ohm cable in the LANs. Specifications for the 16 and 28 multimode F.O. system with capabilities of transmitting 10,000,000 bits per second (BPS) are as follows:

- cable sheath with a PVC outer jacket
- the center member is a Kevlar dielectric with reinforcement for tensile strength
- F.O. core diameter: 62.5 microns +/- .003
- F.O. core cladding diameter: 125 microns +/- .003
- [illegible]
- Attenuation at 850 nm: 3.0 dB/km max
- Attenuation at 1300 nm: 1.0 dB/km min.

The Ethernet coaxial cable specifications are as follows:

- Cable sheath with yellow PVC outer jacket ring-band stripes at 2.5 meter intervals for transceiver tap-in
- Core: solid tinned copper .0855 rated at 1.42 Ohms per meter and 4.66 Ohms per kilometer
- Shield: aluminum/polyester shield bonded to dielectric 92% trimmed copper braid rated at 1.52 Ohms per meter and 5.0 Ohms per kilometer

The network links fifteen (15) buildings and four (4) trailers at one waterfront worksite in support of the Zone Technology Production Group. Figure 15 provides a geographic overview of the shipyard and the networked buildings, while the following table presents the major functional responsibilities housed in the various building:

Building	Primary Function
3	Production Department Service Group
4	Engineering Management Center
5	USS Kitty Hawk (CV 63) remote SNAP computer site and Shipyard Supply
7	Combat Systems
11	Zone Technology Outfit Planning Section and Zone Technology Production Group
12	Production Engineering Division and HP&A Test Division (Engineering & Executive Branch)
22	Production Dept. Mechanical/Machinery Group
57	Production Dept Structural Group
83	Management Information System Center
121	HP&A Test Division and Quality Assurance Offices
541	Mold Loft, Shop 11
620	USS Kitty Hawk (CV 63) ship's shipyard shore site
624	Supply Support Services
990	Central Production CAD/CAM Facility and Sheet Metal Shop, Shop 17
1000	Electrical/Electronics Production Group and site of Central Active Star
Trailer site	ZLT Production Trailers

The network consists of links between the following building facilities, building 1000 being the network hub:

Buildings linked	#F.O.pairs	Length of run
1000-121	16	1953'(595m)
1000-22	16	3078'(938m)
1000-11	28	3170'(966m)
11-4	16	2124'(647m)
11-7	16	705'(215m)
11-3	16	1059'(323m)
4-5	16	997'(304m)
4-83	16	l901' (579m)
83-624	16	1636' (499m)
10-57	28	2852' (869mm)
57-990	16	1601' (488m)
57-620	16	3380(1030m)
620-620ext	8	1690'(515m)

Figure 16 provides a systematic illustration of the overall F.0. network throughout the shipyard A description of this system is provided in the following paragraphs.

The total F.O. cable system runs26,146'(495miles)or7,968m (7.97km). Building 1000, the Hub of the outside plant system, provides the location for the Central Active Star.

The Central Active star network design has established building1000as the geographical hub linking facilities in the easterly and westerly sectors of PNSY. The network has established aready-now system and provisions to meet demands for future expansions. The ready-now system services the following facilities:

Buildings linked	#F.0. pairs	Length of run
1000-11	28	3170' (966m)
11-4	16	2124'(647m)
1000-57	28	2852'(869m)

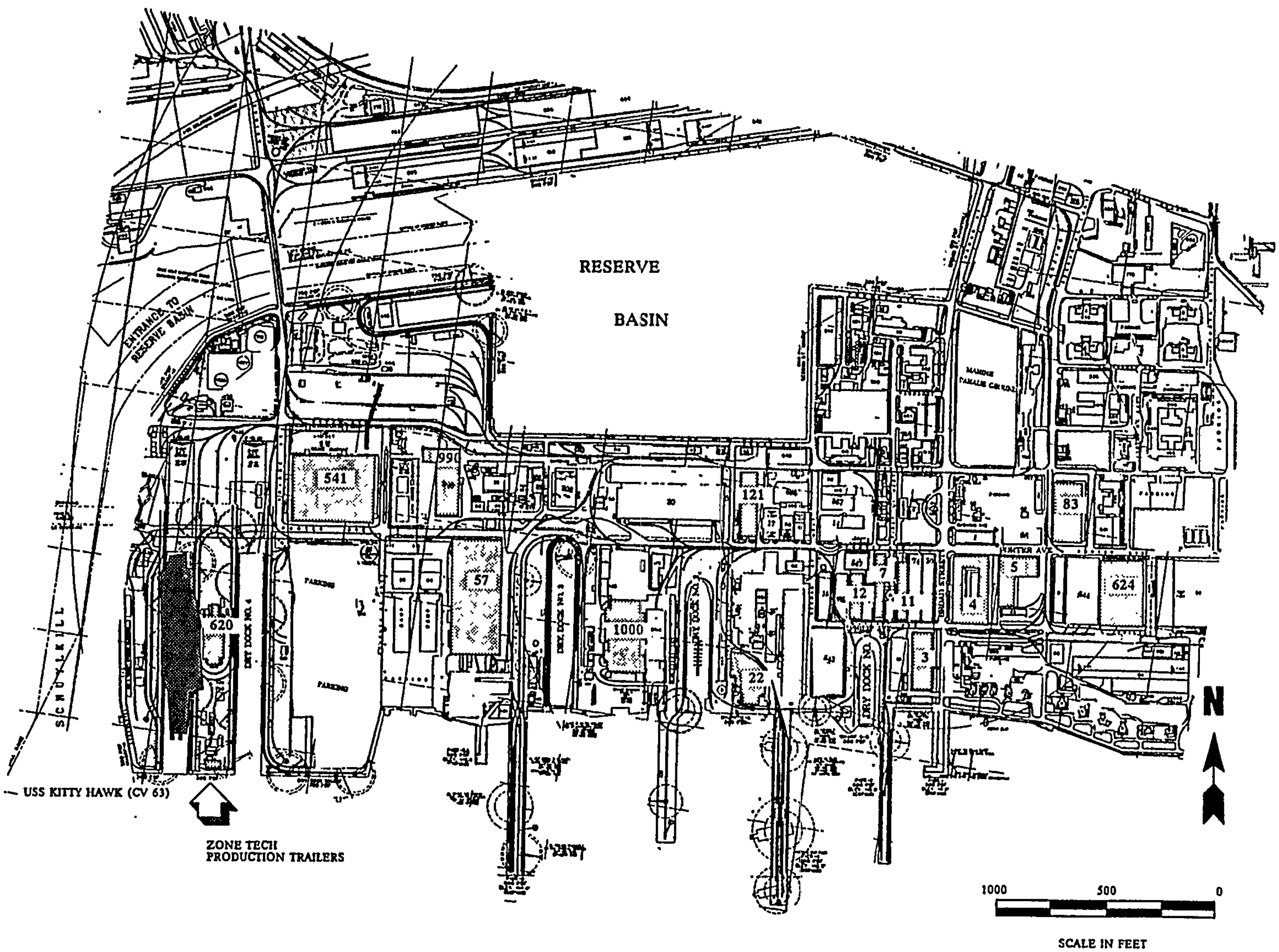
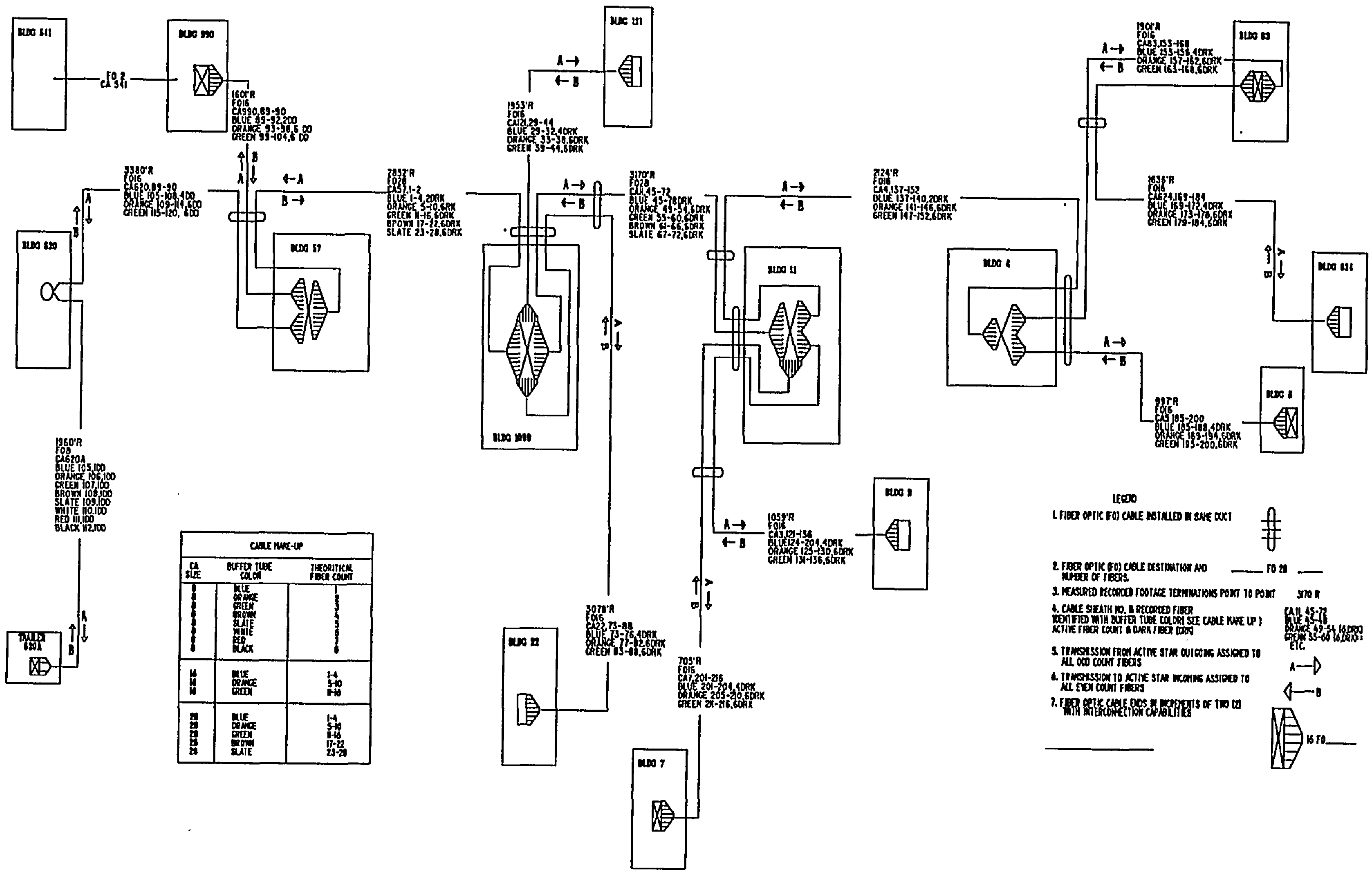


Figure - 15 PNSY F.O. Network Geographic Overview



CABLE MAKE-UP		
CA SIZE	BUFFER TUBE COLOR	THEORITICAL FIBER COUNT
8	BLUE	1
8	ORANGE	2
8	GREEN	3
8	BROWN	4
8	SLATE	5
8	WHITE	6
8	RED	7
8	BLACK	8
16	BLUE	1-4
16	ORANGE	5-10
16	GREEN	11-16
28	BLUE	1-4
28	ORANGE	5-10
28	GREEN	11-16
28	BROWN	17-22
28	SLATE	23-28

Figure - 16 PNSY F.O. Network Schematic Overview

57-990	16	1601' (488m)

The total Central Active Star F.O. cable system runs9,747'(l.8 miles)/2,671m (3.0km). The PNSY demand for future expansion provides an additional 16,399' (3.1 miles)/4,998m (5.0km) of F.O. cable to link the following facilities to building 1000:

Building Linked	#F.O. Pairs	Length of Run
1000-121	16	1953' (595m)
1000-22	16	3078' (938m)
11-7	16	705' (215m)
11-3	16	1059' (322m)
4-5	16	997' (304m)
4-83	16	1901' (579m)
83-624	16	1636' (499m)
57-620	16	3380(1030m)
620-62Ocxt	8	1690 (515m)

Utilizing building 1000 as the network design hub provides F.O. cable expansion capabilities of 26,146' (4.95 miles)/7969m (8.0km) that will ultimately link up and service sixteen (16) facilities. Already existing underground conduit provided a means whereby single ducts were used to accomodate several feeds into the building facilities.

The system design minimized connectorization by utilizing patch panel (pp) frames at designated building sites. The patch panel sites provide optimum utilization of F.O. for a Concentration Point (CP) in building 1000. The strategically located interconnection patch panel sites gain the advantage of circuitry (F.O.) traffic control management and diversification of full period F.O. performance.

The five PP interconnection sites interface a total of 72 F.O. pairs through the Central Active Star, with 80 F.O. pairs in reserve for future expansion. The elimination of F.O. field straight splices has provided a minimal attenuation loss. The F.O. cable was delivered at an average of 1.5 dB per km, providing a transmission advantage from the maximum specified 3.0 dB at 850 mm bandwidth.

STATUS AND CONTROL DATABASE MANAGEMENT SYSTEM

The Status and Control database is the heart of the Unit Work Instruction (UWI) and Shop Work Instruction (SWI) automated system This control system development was, by design, restricted to the use of previously selected hardware and software elements of the Zone Logic computer subsystem. This decision required maintaining storage of data, graphics and text in its native form on the particular subsystem through which the data was input or generated. The major drawback to this is restricted configuration and limited data update control by the originator. Multiple versions of a file can exist if manual control procedures are not employed. Improvement of this limitation is to be addressed in a future update utilizing the incorporation of a distributive. database concept, a concept which is very much a state-of-the-art technique in database management

The Status and Control Database System is a multi-user database application developed using dBase III Plus technology (to go to dBase lV when available) and running in a Novell PC network environment. A discussion of the Global design information for the database system, covering the module structure of the system, module independent design criteria and the software technology used to implement the system is provided in the following paragraphs.

The fundamental software development technology used to implement the Status and Control Database System is dBase III Plus, a relational database system that incorporates a command language interpreter. It can be used to develop a database application running in either a single or multi-user environment Because it is easier to develop code in an interpreted environment, the command language interpreter was used to do the initial source code development. As modules were completed, initial testing was performed and necessary modifications were made.

In addition to traditional coding methods, a dBase IlI Plus program generator called the UI Programmer was used The UI Programmer is a software tool that generates dBase III Plus source code for menuing, data entry and report forms. The code generation is based on source code templates provided by the programmer.

A compiler called Quicksilver that supports the dBase III Plus command language was used to produce the production version of the database system. The compiled code has several advantages over interpreted code in the production system, chief among these being the speed of execution. While interpreted code is in essence compiled every time it is executed, compiled code is only compiled once. Compiled code is also more immune to changes by the user community as the source code need not be kept on-line. This means that the syntax written by the programmer, once compiled, is the object code (machine language). Thus, the user can not make changes arbitrarily. This restricts changes to that individual or set of individuals controlling the compiler set by keeping the program of line and free from potential tampering. The RAM memory needed to execute compiled code is substantially less than that required to execute identical interpreted code because the memory space taken up by the interpreter itself is not required.

AdBaseIII Plus application consists of two primary elements: data tables and code modules. The data is stored in the data tables with the code modules providing an interface between the users and the data that allows for easy data access while still protecting the integrity of the data.

The Status and Control Database System consists of several primary data tables and a hierarchical set of code modules. These data tables and code modules are grouped into the following functional subsystems:

- Job Order Production Control (JOPC) subsystem
- UWIsubsystem
- Library Component subsystem
- Material subsystem

The subsystem boundaries are not strictly enforced. Code modules from one subsystem may access data tables from a different subsystem and invoke additional code modules from yet another subsystem. None the less, the subsystem organization is a convenient one to use when planning the development of the system. Figure 17, Data Table Subsystem, provides a pictorial representation of the data table subsystem. A description of each of the data tables follows:

1)The master job order production Control(JOPC) List has one record for each JOPC in the system. It contains the JOPC number (#), its current production status, pointers to a number of subordinate databases and a number of related JOPC data items, such as its title and the planner's name.

2) The JOPC Shop Man-Hour List is subordinate to the Master JOPC List. It contains one record for each shop/man-hour pair on the JOPC. Each record includes a JOPC #, a shop #, and a number of man hours

3)The JOPC/UWI Task Assignment List is subordinate to both the Master JOPC List and the Master UWI List. It contains one record for each JOPC task defined in the system. It also contains information that defines the task and specifies which UWI it was assigned to. It includes the JOPC #, the UWI# to which the task was assigned, a unique identification number, the shop # and the number of man-hours being allocated and, if possible, a descriptive definition of the task. A JOPC is considered to consist of a number of tasks, each of which must be assigned to a UWI before the JOPC can be considered completely allocated

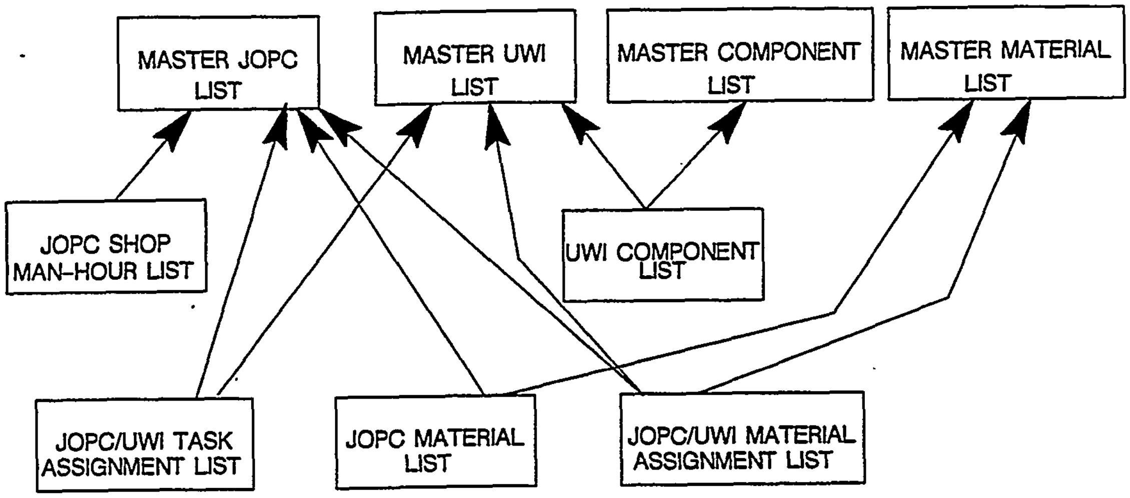


Figure - 17 Data Table Subsystem

4) The JOPC Material List is subordinate to both the Master JOPC List and the Master Material List. It lists the JOPC#, stock # and quantity of each item assigned to the JOPC.

5) The JOPC/UWI Material Assignment List is subordinate to the Master JOPC List, the Master UWI List and the Master Material List. It contains the JOPC #, the UWI #, the item stock # and the quantity assigned to a particular UWI.

6) The Master UWI List has one record for each UWI in the system- It contains the UWI #, its current production status, pointers to a number of subordinate databases and a number of related UWI data items such as the preparer's name.

7)The UWI Component List is subordinate to the Master UWI List and the Master Component Text and Drawing List. It contains one record for each text or graphic component required to complete a particular UWI and includes the UWI # and the unique component #.

8) The Master Component Teat and Drawing List contains one record for each scanned drawing or text component. It contains a unique identification number, the original reference number for the text or drawing, descriptive information about the original reference material, and data concerning the scanning and on-line storage of the material.

9) The Master Material List contains one record for each stock item reference listed in a JOPC material list- It contains information such as the stock #, name, description and estimated cost of the item.

The Status and Control System is designed to be a 'bulletproof' system- It should not be possible for the user to issue inadvertent commands that destroy or corrupt the data- The user interfaces to the database system consist primarily of menus, data entry forms and report forms- All of these interfaces are similar in appearance. With a single interface type, such as data entry forms, the design and appearanee of all instances of that interface type are identical, with only minimal allowances made for the differing requirements of each situation- This was accomplished primarily through the use of the UI programmer' software development tool.

In most cases, a data entry form performs three different user functions data entry, data modification and data review. In order to allow for review without the possibility of inadvertent modification, all functions that update the database must be confirmed by the operator. All source code modules are formatted in a similar manner. It is not possible, with only a quick look at the file, to determine the programmer responsible for the code. Figure 18, Code Module Hierarchy, provides a pictorial representation of the code module subsystems. A description of each of the code modules follows

1) The Master Menu code module does not belong to any of the subsystems. It implements the initial user interface and prompts the user to select one of the subsystems (JOPC,UWI, Component or Material) and invokes that subsystem's menu module.

2) The JOPC Menu code module prompts the user to select one of the JOPC functions and invokes the related code module.

3) The JOPC Definition and Data Entry module supports entry and modification of the data from the JOPC form- This data is used to create or modify records in the Master JOPC List and the JOPC Shop Man-Hour List

4) The JOPC/UWI Task Assignment module supports the definition and modification of JOPC tasks and their assignment to a UWI. A record is added to the JOPC/UWI Assignment List for each defined task. If the UWI to which the task is assigned doesn't already exist, a recode is added to the Master UWI List and the user is prompted to enter the UW definition data (it calls the UWI Definition code module).

5) The JOPC Matcrial Definition module supports entry and modification of data pertaining to the material allocated to a JOPC on its associated Job Material List (JML). One record is added to the JOPC Material List for each item- If the item is not already entered in the Master Material List, the user is prompted to enter the item definition data (it calls the Material Item Definition code module).

6) The JOPC/UWI Material Assignment module supports the assignment of a JOPC's material allocation to its subordinate UWIs. A record is added to the JOPC/UWI Material Assignment List for each assigned item. If the UWI to which an item is assigned doesn't exist ,the user is prompt to enter the

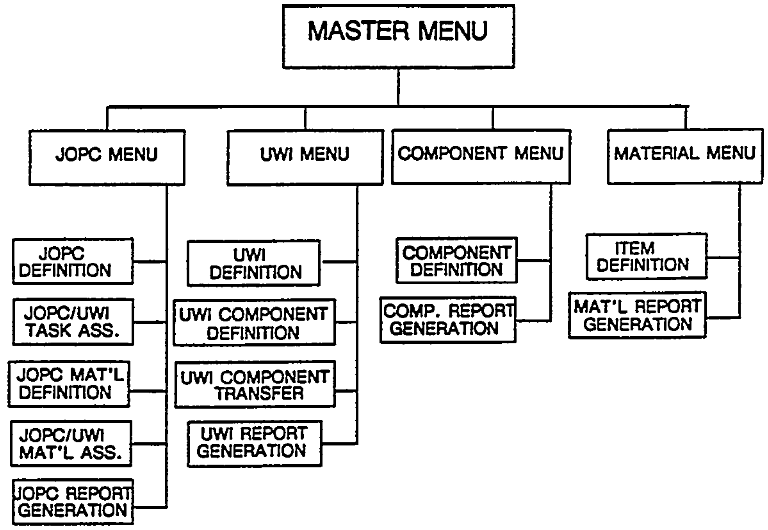


Figure - 18 Code Module Hierarchy

UWI definition data (the module calls the UWI Definition code module).

7) The JOPC Status Report Generation module generates a report listing all or some subset of the JOPCs in the system, This report can be generated in several formats- The short format shows only data that can be comfortably fit on an 80 character line and emphasizes production status. Option will allow the the to include UWI assignments, material allocations, UWI material assignments and, as a group, all the related data-

8) The UWI subsystem code modules will initially be operated without either the JOPC or Material modules. The Component modules will be present in the initial system-

9) The UWI Menu module prompts the user to select one of the JOPC functions and invokes the related code module.

10) The UWI Definition and Data Entry module supports entry, modification and review of the UWI boilerplate data and its publication status data- Records are added to the Master UWI List- This module is also invoked by several JOPC modules.

11) The UWI Component Definition module supports entry, modification and review of the list of teat and graphic components required to publish a UWI. A record is added to the UWI Component List for each component. If the component is not already on-line., the user is prompted to enter component definition data (the module calls the Component Definition code module).

l2) The UWI Component Transfer module supports the transfer of on-line components from the system where they are stored to the local PC for further processing. This is accomplished by programming the dBase III Plus code to issue File Transfer Protocol (FTP) commands.

l3) The UWI Status Report Generation module generates a report listing all or some of the UWIs in the system- The report can be generated in several formats. The short format will display only the data that can be comfortably fit on an 80 character line and will focus on the publication status of the UWI. Optionally. the user can request that JOPC task assignments, JOPC material assignments and/or related data be included in the report.

14) The Component Data Entry and Definition module sup ports entry, modification and review of the text and graphic components available for inclusion in a UWI. One record is added to the Master Component List for each component. This module can also be invoked by the UWI Component Definition module.

15) The Component Status Report Generation module generates reports listing all or some of the components in the system. The report can be generated in several formats. There are two short formats. Each will display only that data which can be comfortably fit on an 80 character line. One format will address those components that need to be scanned while the other addresses those components that are already on-line. The comprehensive format will display all stored data for each component.

16)The Material Item Definition and Data entry module supports the entry, modification or review of material item definitions. One record is added to the Master Material List for each new item. This module is also called from the JOPC Material Definition module.

17)The Material Status Report Generation module generates reports listing some or all of the material items in the system.

BENEFITS

while it is still too early to be able to provide detailed cost savings realized by the implementation of the ZLT CAD/CAM Networked DBMS, several instances of savings or benefits in design, planning and production man-hours have already been noted:

1) The scanner was utilized to help develop preplanned routing and location diagrams for the placement of tank suction and cleaning lines used to dean some 720 tanks onboard USS Kitty Hawk- This, coupled with ZLT principles of planning and management, helped realize over a $2 million savings, with all tank cleaning work completing on schedule and definitely under budget.

2) The Mold Loft has used the upgraded UGII CAD/CAM system on various projects such as in the development of drawings for mast work, foundation work and for a new bulbous bow for USS Kitty Hawk- All of these tasks were completed on schedule and budget due to the assistance of this new equipment. Mold I-oft personnel have found the UGII upgraded system so efficient that it is manned constantly and used to replace manual methods as much as possible.

3) The design division has utilized the new CAD equipment in developing a first for PNSY in a design for production work package of USS Kitty Hawk pump room number five (5). Original design effort amounted to 400 mandays. After becoming familiar with the new sytem, time requirements for the next pump room will be reduced by half and will be ahead of scheduled completion by one month.

4) Utilization of the new peripheral electrostatic color plotter allows for the printing of colored drawings in only ten (10) minutes. Compared with the previous norm of two (2) hours per color pen-plotted drawing this is proving to be a major savings not only in the production of multiple copies of multicolored damage control plates, but also in the drawing of 2-D and 3-D configuration overlays.

5) Regarding the utilization of the numerous PCs, continual usage of the PCs has proven to be a necessity to handle the volumes of data to be sorted and distributed on a real-time basis in support of the shipyard's ZLT efforts.

6) The scanners are used daily to input drawings to the GAD system for supporting production work and allowing for clearer understanding and definition of work to be performed.

7) Total development of UWIs is not fully automated at this time, but at full implementation it is expected to significantly reduce the time/cost to develop UWIs.

In all, these illustrate only a few isolated eases of the benefits being realated from the installation of the ZLT CAD/CAM Networked DBMS.

SUMMARY

As is evident, many innovations have been implemented at PNSY in a relatively short interval- Major changes to management, work packaging, production, planning and design are infull swing in support of the ZLT efforts being applied to thirty (30) percent of USS Kitty Hawk's SLEP. The project is progressing well with all planned targets being met and the ZLT CAD/CAM and Networked DBMS scheduled to be completed by fall of 1988. Plans are also being worked to increase PNSY ZLT efforts on future ship overhauls.

The accomplishment of this much in such a short time can be mainly attributed to four (4) key factors. First, a "war time' condition was initially enacted to ensure the success of the Hull Expan-Sion Project. Thus, eventhough the project was eventually cancelled some thirteen (13) months later, it would have been too costly to retreat, let alone stop what had already been put in motion. Second, senior shipyard management are behind the project and have given it their full support; it cannot be stressed enough how critical this has been to the success of the project thus far. Third a project Office was established to direct and manage all ZLT related matters-Fourth, an SI was used and has performed extremely well and been an irreplaceable asset to the program.

The basic approach in developing this project has been to maximize technology transfers with IHI and other sources wherever possible. investigations of industrial and manufacturing facilities have proven invaluable, as has heavy involvment by PNSY with the National Ship Building Research Program (NSRP). The ZLT Project Office's philosophy has been one of "going out and kicking the tires, getting smart quick, analyzing the data, making the decisions that they are being paid to make, and following through on the execution of the game plan." Naval Shipyards must quickly become more competitive; buying "futures' or getting heavily involved in development efforts while needs go unfulfilled will only work to the detriment of shipyards.

With the rate at which the computer industry is moving, it is certainly realised that by the time computer hardware and software is received and installed, it is already obsolete. Or is it? The dozens of computer periodicals available (which basically sell futures) seem to always have computer managers looking for that one R2-D2 done that will solve. all of one's problems in one clean sweep. Is it actually realistic to study periodicals and make plans based on just what one reads? Or is it more objective to actually perform real-time technical evaluations? These authors vote for the latter. Once you have seen and understood, there is no turning back

A perfect example of this is the instalation of PNSY's F.O. LAN. Initially, shipyard personnel managers were sceptic, basically out of lack of knowledge of fiber optics. Once the SI brought in highly qualified fiber optic engineers and technicians, shipyard fears and doubts were put to rest. In fact., it took only six weeks to install this system. If that isn't an example of "kicking the tires, getting smart quickly and making a sound technical and business decision" that fiber optic technology today is good enough to go with. then the authors are not sure what is. The decision to go with 32.bit microcomputers operating on MS-DOS vice going to OS-2 is another example of going with what the market has proven as a winner to date Also, by following the lead of private industry and the SI, the acquisition of scanner technology has been made a reality at PNSY.

Regarding the use of an SI, as stated earlier, if managed properly and if true professional lines of communication are established and maintained, it is hard for the authors to see how anything short of success can occur.

Throughout this project, Cost, Schedule and Control (CS^2) procedures were used as one of the major tools to monitor and progress the SI. To this end, the maintaining of schedule and budget has been a reality.

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